

ASTEROID SPINS: FROM THE VERY FAST TO THE VERY SLOW

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The application of CCD photometry to monitoring the light variations of very small asteroids has led to an explosion of data available, and perhaps as importantly, has made it possible to probe fainter, and hence smaller asteroids. In this paper, we review several new results from the analysis of such lightcurve data, much of it taken by the late W. Z. Wisniewski, a native of Poland who studied at Poznan University.

At the time of the last close pass of the asteroid 4179 Toutatis by the Earth in 1992, it became apparent from radar observations that the asteroid was in a bizarre rotation state, and that the rotation rate was extremely slow. A re-evaluation of a work by Burns and Safronov (MNRAS 165, 403, 1973) indicated that very small and slowly rotating asteroids can have a time scale of damping into a principal-axis rotation state which is long compared to their expected collisional lifetime, or for that matter, the age of the solar system, thus such a small, slowly spinning body might be expected to be in an undamped, or "tumbling" rotation state. Lightcurve observations confirmed that Toutatis is indeed in such a rotation state. Lightcurve observations of several other small Earth-approaching asteroids indicate that they too are in "tumbling" rotation states. Perhaps most interesting among these is the asteroid 253 Mathilde, which is a flyby target of the *Near-Earth Asteroid Rendezvous (NEAR)* space mission. As yet, we have no understanding of why some asteroids have such very slow spins (with rotation periods of many days or even weeks). Perhaps the *NEAR* flyby may reveal some clue.

At the other end of the rotation rate spectrum are some small asteroids which are spinning so rapidly that they are nearly in a state of tension, with centrifugal acceleration at the equator nearly equal to the self-gravitational acceleration. We have recently re-analyzed the distribution of spin rates of small (<10 km diameter) asteroids. With the benefit of the larger data set now available, it appears that the distribution of spins is *truncated*, rather than smoothly decreasing to zero (population) with decreasing spin period, with the threshold being at a period of $\sim 2\frac{1}{4}$ hours. This suggests that indeed the spin rate of asteroids is limited by the rate at which the body would become in a state of tension, which in turn implies that even such small asteroids are not monolithic bodies. Furthermore,